UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

July 31, 2023

Mr. Daniel H. Dorman
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: FRAMATOME TOPICAL REPORT ANP-10339P, "ARITA™ – ARTEMIS™/RELAP™ INTEGRATED TRANSIENT ANALYSIS METHODOLOGY"

Dear Mr. Dorman:

During the 707th meeting of the Advisory Committee on Reactor Safeguards (ACRS), July 12-14, 2023, we completed our review of the Framatome Topical Report ANP-10339P, "ARITA™ – ARTEMIS™/RELAP™ Integrated Transient Analysis Methodology," and the associated staff draft safety evaluation (SE). Our Accident Analyses - Thermal Hydraulic Subcommittee reviewed this topic on June 22, 2023. During these meetings, we had the benefit of discussions with the staff and representatives from Framatome. We also had the benefit of the referenced documents.

CONCLUSIONS AND RECOMMENDATION

1. The evaluation model (EM) documented in topical report ANP-10339P conservatively accounts for uncertainties in transient analyses for conventional Westinghouse and Combustion Engineering pressurized water reactors (PWRs).

2. The limitations and conditions (L&Cs) in the draft staff SE report provide comprehensive guidance for applicants and future reviewers to ensure that the ARITA™ methodology is used within its validation range.

3. The SE report should be issued.

BACKGROUND

ARITA™ defines a methodology to apply uncertainties using a well-defined statistical sampling process and biases to apply when the uncertainty is difficult to quantify. An example of bias is the use of limiting radial power peaking factors, which are set to technical specification limits and not sampled.

The three-dimensional (3D) EM to calculate the transient response relies on previously approved codes: S-RELAP5™, a system thermal hydraulics code used for components outside the nuclear core; and ARTEMIS™, a detailed core and channel analysis code. S-RELAP5™ calculates the system response (e.g., flows, pressures, and power). ARTEMIS™ calculates the core power and fuel response using one of two different modes: nodal mode, with four radial nodes per fuel assembly; or detailed mode, where subchannel analysis is used to calculate departure from nuclear boiling (DNB) limits on the hot fuel pin. These codes share data with legacy Framatome codes, including: GALILEO™ to evaluate thermal-mechanical fuel rod performance; APOLLO2-A™ to generate cross sections; and COBRA-FLX™ for sub-channel calculations. These Framatome codes are legacy methods that have been reviewed and approved previously and have a proven record performing safety analyses.

Most transients are calculated using the ARITA™ 3D neutronics EM, but two other EM variants use approved legacy methods for special cases: a zero-dimensional (0D) EM variant based on S-RELAP5™ with the built-in point kinetics model for events involving systemwide thermal-hydraulic behavior for which a detailed core model is unnecessary; and a static EM variant for events focused upon phenomena within the reactor core for which systemwide thermal-hydraulic conditions remain at fixed conditions. In addition, the rod ejection accident is not analyzed with ARITA™ but continues to use the deterministic approach outlined in the approved AREA™ - ARCADIA® methodology.

DISCUSSION

The ARITA™ statistical methodology to quantify uncertainties uses the nonparametric statistics treatment known as the Wilks Method, which defines the number of calculations needed to determine the desired 95% probability level at the specified 95% confidence level (95/95). To this end, a series of ARITA™ calculations are performed by sampling from the uncertain input parameters. The most limiting figure-of-merit (FOM) calculated in these runs is guaranteed to bound the actual FOM with at least 95/95 confidence. This statistical analysis is well known, and it has been applied to previously approved methods. The staff concluded that the ARITA™ implementation is acceptable. We concur.

The ARITA™ statistical method is applied to the calculation of FOMs, which are judged against their applicable limits. Each FOM depends on the accident scenario. Examples include: specified acceptable fuel design limits (SAFDLs) such as departure from nucleate boiling, fuel centerline melt, or transient cladding strain; system performance parameters such as peak reactor coolant system pressure, peak secondary system pressure, pressurizer overfill, steam generator overfill, loss of subcooling margin; and required operator action times.

The staff SE assessed the acceptability of the ARITA™ methodology by reviewing the following topics: accident scenario identification; applicable regulations; phenomena identification and ranking table (PIRT); EM development and assessment; calculational procedures; and input parameter treatment. The staff also evaluated supplementary EM features of the ARITA™ methodology including boron dilution, treatment of mixed cores, power distribution control, setpoints, and reconstituted fuel assemblies.

The topical report contains an extensive validation matrix, including: separate effects tests; component effects tests; integral effects tests; plant transient data; foundational methodology assessment; and conservative methodology assessment. The staff concluded that there is reasonable assurance that the ARITA™ methodology has adequate capability for modeling conventional Westinghouse and Combustion Engineering PWRs for applicable transient and accident conditions.

The SE report imposes a large number of L&Cs. However, most of these L&Cs establish a well-defined applicability range of the methodology. For example, L&C #1 anticipates that some plants may have a licensing basis that deviates from the Standard Review Plan (SRP) guidance in NUREG-0800. It defines the range of applicability of the methodology and a process forward if the range is exceeded. Thus, the large number of L&Cs does not reflect on the quality of the topical report but is intended to simplify future reviews by clearly defining the review criteria.

In their SE, the staff challenged the treatment of uncertainties for fuel axial peaking factors (specifically parameters LCN-15b1 and LCN-15b2, also known as the F_Z term.) The staff concluded that additional justification for the proposed treatment of uncertainties is needed. In the meantime, L&Cs 18 and 19 allow for an alternative conservative treatment until such justification is provided. Framatome stated that they are working on a resolution to remove what they consider the excessive conservatism in these L&Cs. Resolution will require issuing either a revised topical report or a supplement. Both routes could be time consuming, and we encourage the staff to maintain lines of communication with Framatome to ensure that the revision addresses adequately all the staff concerns without the need for iterations in the form of future requests for additional information.

SUMMARY

The EM documented in topical report ANP-10339P conservatively accounts for uncertainties in transient analyses for conventional Westinghouse and Combustion Engineering PWRs. The L&Cs in the draft staff SE report provide comprehensive guidance for applicants and future reviewers to ensure that the ARITA™ methodology is used within its validation range. The SE report should be issued.

We are not requesting a formal response from the staff to this letter report.

Sincerely,

Signed by Rempe, Joy on 07/31/23

Joy L. Rempe
Chairman

REFERENCES

1. Framatome Inc., "ANP-10339P, Revision 0, 'ARITA™ - ARTEMIS™/RELAP™ Integrated Transient Analysis Methodology'," August 2018, (ML18242A480).

2. AREVA NP, Inc., "ANP-10297P-A, Revision 0, 'The ARCADIA® Reactor Analysis System for PWRs Methodology Description and Benchmarking Results'," February 2013, (ML14195A145).

3. AREVA NP, Inc., "ANP-10297, Revision 0, Supplement 1P-A, Revision 1, 'The ARCADIA® Reactor Analysis System for PWRs Methodology Description and Benchmarking Results'," December 2020, (ML21071A062).

4. Framatome Inc., "ANP-10311P-A, Revision 1, 'COBRA-FLX™: A Core Thermal-Hydraulic Analysis Code'," October 2017, (ML18103A138).

5. Framatome Inc., “ANP-10323P-A, Revision 1, ‘GALILEO™ Fuel Rod Thermal-Mechanical Methodology for Pressurized Water Reactors’,” November 2020, (ML21005A028).

6. Framatome Inc., “ANP-10349P-A, Revision 0, ‘GALILEO™ Implementation in LOCA Methods’,” November 2021, (ML21354A136).

7. Framatome Inc., “ANP-10338P-A, Revision 0, ‘AREA™ - ARCADIA® Rod Ejection Accident’,” December 2017, (ML18059A753).

8. Framatome Inc., “ANP-10341P-A, Revision 0, ‘The ORFEO-GAIA and ORFEO-NMGRID Critical Heat Flux Correlations’,” September 2018, (ML18284A039).

9. Siemens Power Corporation, “EMF-1961(P)(A), Revision 0, ‘Statistical Setpoint / Transient Methodology for Combustion Engineering Type Reactors’,” July 2000.

10. Siemens Power Corporation, “EMF-92-081(P)(A), Revision 1, ‘Statistical Setpoint / Transient Methodology for Westinghouse Type Reactors’,” February 2000.

11. United States Nuclear Regulatory Commission, NUREG/CR-5249, Revision 4, “Quantifying Reactor Safety Margins - Application of Code Scaling, Applicability, and Uncertainty Evaluation Methodology to a Large-Break, Loss-of-Coolant Accident,” December 1989, (ML030380503).

12. Wilks, S.S., "Determination of Sample Sizes for Setting Tolerance Limits," Ann. Math. Stat., Vol. 29, No. 2, pp. 599-601, June 1958

13. United States Nuclear Regulatory Commission, NUREG-0800, Revision 6, “Standard Review Plan for Light Water Reactors,” March 2007, (ML070810350).

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